

*Aerial view of Connecticut's Church Street South Extension project, which spans the rail yard and cuts across the center of the photo.*



## CONNECTICUT Accelerated Construction Keeps Bridge – and Trains – on Track

### NEW HAVEN BRIDGE CENTER SPAN INSTALLED OVERNIGHT

The New Haven, Connecticut “Big Pick” was a calculated risk whose success hinged on off-site assembly, one of the world’s highest capacity cranes, sure-handed coordination and accelerated construction methods. The assignment: on one weekend, in one night, in three hours, place the center span of the 1274-foot long Church Street Bridge over the New Haven Rail Yard. The objective: lift, carry, swivel and position the 320-foot truss over electrified main line tracks during a track and power outage while minimizing disruption at one of the busiest rail yards in the country.

Most of the tracks include an overhead electrified catenary system providing traction power for the locomotives, signal power for train traffic and overhead feeders for power distribution, with bare copper wires carrying up to 50,000 volts DC. In addition to minimizing impacts to rail operations during the bridge construction, obtaining a temporary track and power outage for construction purposes depended on rail operations within the yard as well as the needs of seven other construction projects that were in progress within the rail yard at the same time as the project, known as the Church Street South Extension (CSSE).

According to Paul H. Breen, P.E., Assistant District Engineer with District 3 of the Connecticut Department of Transportation (ConnDOT), the agency worked carefully with contractor O&G Industries to find the safest, fastest construction sequence that would also prove convenient for customers. The answer: prefabricate and preassemble the 850-ton superstructure out of the way of the active tracks and lift the truss in a single shot with the Lampson Transi-Lift® 2600 crane.

Breen recalled, “The project entailed crossing at least ten active rail lines and taking the tracks out of commission for part of one evening only. Conventional construction would have caused numerous track outages, interference with passenger usage, and high costs for the number of personnel that the railroad would have had to supply to the project.”

The operation demanded a crane capacity of 1,550 tons at the pick radius of 186 feet. As over 500 spectators looked on in the 2:30 AM darkness of May 4, 2003, the crane walked the 1048 tons of truss and rigging about 100 feet before rotating it into final position.

### The Pick

The Big Pick was a dramatic milestone during the CSSE project that re-connected New Haven's downtown area with its harbor waterfront for the first time since the mid-1880s and afforded new local access for vehicles, pedestrians and bicyclists. The CSSE included the eight-span Church Street Bridge over the New Haven Rail Yard consisting of three segments. Segment 1 is a 134-foot single span structure. Segment 2 is a 320-foot long simple span structure; and Segment 3 is an 817-foot long, 6-span continuous structure.

The CSSE project entailed 1,650 feet of reconstructed roadway, modification of two intersections, and the installation of 1200 feet of 12' x 4' precast-concrete box culvert to replace a substandard storm drainage system. The bridge consists of two 11-foot wide traffic lanes, a median, sidewalk, and two bike lanes and shoulders.

When the ribbon was cut and the bridge opened to traffic in December, 2003, the CSSE project of over \$31 million had been completed five months ahead of schedule and \$500,000 under budget, despite daunting constructability challenges inherent in erecting a bridge superstructure near active rail lines. The cooperative, partnered effort combined the engineering, technical and management expertise of a full range of stakeholders during design and construction. Besides finishing one half-million dollars under budget, the non-traditional Big Pick implementation (as opposed to more conventional erection methods) is estimated to have saved an additional \$1,000,000 in railroad force account costs.

The project as a whole, and the "Big Pick" in particular, produced both best practices and lessons learned for other States to apply where large-capacity cranes or innovative erection methods will minimize disruption to project abutters. The Big Pick has been selected by the Federal Highway Administration's Highways for LIFE (HfL) program as an HfL success story for its use of innovative processes and practices for better, safer, longer-lasting bridges and roadways.

### Prefabrication and Preassembly

The success of the "Big Pick" hinged on a prefabricated, preassembled truss center span that was a first for a dominant project stakeholder: Metro-North Railroad (MNRR). According to MNRR Project Coordinator David W. Jacobs, P.E., "Fabricating the entire truss offsite – adjacent to the railroad and then erecting it over our right-of-way had never been done over Metro-North before with a bridge of that span length. This method saved the State hundreds of thousands of dollars in railroad force account costs. As important to the railroad, there was an absolute minimum of disruption to our service since only one track and power outage, totaling only a few hours, was required."

## THE BIG PICK TEAM

Connecticut Department  
of Transportation

Federal Highway  
Administration

Parsons Brinkerhoff  
Quade & Douglass

O & G Industries

City of New Haven

Gannett Fleming

Metro-North Railroad

The steel-galvanized truss was a key element of the bridge over the New Haven Rail Yard, whose limits on outages and workspace in and around the tracks dictated the structure type and construction methods for the truss. No intermediate supports were allowed in the main line track area between the two end piers for the purpose of constructing the main span, so the truss could not be built in place using conventional methods. The bridge's decks, piers and abutments were cast in place and not subject to the same constraints.

Prefabrication of the truss, assembly off-line from the proposed bridge alignment, and installation after assembly were logical solutions to the truss erection. Over several months, the team assembled the span. The Pick itself would follow a step-by-step sequence planned and tested ahead of time.

### Mega Crane

Meticulous discussions with crane companies proved that the large capacity crane approach would be most feasible, cost-effective, and customer-friendly. The Church Street Bridge would cross closely spaced tracks in constant use for commuter and freight services. Avoiding impacts to operations during construction was a paramount challenge, although there were others: for instance, seven other construction projects were in progress in the rail yard at the same time.

Design firm Parsons Brinkerhoff Quade & Douglas developed, with the railroads and ongoing rail yard project partners, detailed crane erection plans. Specifications stipulated that the steel truss be picked after the structural steel was fully assembled, but before the concrete deck was cast. The lifted load, including the truss, remain-in-place forms and rigging, was estimated at 1048 tons. Metro-North Railroad required that the crane capacity exceed 150 percent of the lifted load.

The crane of choice was formidable. It arrived in more than 200 tractor-trailer loads of parts. Although crane erection in the bridge industry is commonplace, the Big Pick pushed the state of the art with the Lampson Transi-Lift® 2600, the largest mobile, land-based, and high-capacity crane in existence. Its maximum capacity is 2600 tons and it has a 1,532-ton capacity at 176-foot radius with nearly 3,200 tons of counterweight. The mega-crane is manipulated by three crew members with a ground superintendent. It takes at least four weeks to assemble and another four to demobilize.

Before the crane could even enter the picture, though, the team had to build a pad to support it. Land in the entire rail yard had been filled to its current elevations, with the northern half once being shorefront and the southern half having been tidal lands. Poor soil conditions required that the mega crane be supported by a foundation consisting of a three-foot thick reinforced concrete mat supported on two feet of compacted stone base. Plans for the crane pad alone specified six feet of excavation depth, 28 inches of stone, eight inches of gravel, and 36 inches of 5000 PSI concrete. Not only would the team build the pad; they would also remove it and restore the site to its original condition after the lift.

### Context Sensitive Design

The pad restoration, in fact, was just one of numerous ongoing environmental stewardship and community-minded initiatives. Another snapshot from the bigger picture: context sensitive design. Bridge architects worked closely with New Haven's City Plan Department to create aesthetic bridge features that mirrored the local setting. In selecting the superstructure, for instance, they opted for a through-truss with a parabolic top chord that would be compatible with the rail yard environment.



*The “Big Pick” underway: the 320-foot steel truss center span of the Church Street Bridge over the New Haven Rail Yard is lifted into position.*

Other bridge features captured the gateway and maritime themes of the local environment. For example, concrete pylons were introduced at each end of the bridge to suggest a gateway. Ornamental light fixtures atop the pylons echoed a New England lighthouse theme. To satisfy safety requirements and ensure context-sensitive design, customized aluminum fencing was employed along bridge parapets within the limits of the rail yard.

The project epitomized the historic National Highway System Design Standards policy adopted by the American Association of State Highway and Transportation Officials to encourage context sensitive design. The AASHTO policy advocated a “design process for NHS routes that integrate safety, environmental, scenic, historic, community and preservation concerns, and... standards which also foster access for bicycles and pedestrian traffic along with other transportation modes.”



## Effective Collaboration

Coordination and communication anchor undertakings as complex as the CSSE. Rail stakeholders were quite diverse. The New Haven Rail Yard is owned by ConnDOT. Metro-North Railroad operates and maintains the yard. Amtrak, Providence & Worcester, Conrail and the Connecticut Commuter Railroad hold track operating rights.

Informing the coordination effort was the fact that, in the design phase of the CSSE, plans to reconstruct the entire yard over the next eight to ten years were already in existence. Two construction contracts were underway to reconfigure and reconstruct interlocking track and catenary systems, and other projects were being designed. The CSSE joined forces with other stakeholders as part of the New Haven Interlocking Reconfiguration Program. Integrating CSSE design and construction into the fast-paced, congested rail yard was crucial.

Pier locations and layouts were closely coordinated with all planned and ongoing rail yard improvement projects to avoid conflicts with existing or proposed facilities or operations. As part of the contract documents, the designer prepared detailed Work Area Layout Plans of locations that could support the CSSE contractor's operations. In addition to the truss erection, recommended erection methods for the other segments of the Church Street Bridge were crafted in great detail to make sure the project was constructible, given the constraints of the rail yard.

When close collaboration revealed additional work areas created from demolition of rail yard facilities, O&G Industries seized the opportunity to request permission for a game-changing improvement: assemble the truss offline from the proposed bridge alignment. The original design called for the truss to be temporarily supported by the newly constructed bridge piers during assembly due to limited work space. The team's cooperation and O&G's foresight greatly simplified the job and curbed construction time.

As Jacobs put it, "For the operation to be safe and successful for the railroad as well as the contractor, the sequencing of multiple events had to be thoroughly coordinated and planned down to the minute. In addition, an extensive communication system had to be established for use during the operation to insure that the complicated sequencing of events took place as planned."

## High Performing Materials

Pursuing collaboration and other solutions to heighten mobility, elevate safety, save time and control costs – all precepts of FHWA's Highways for LIFE program – did not deter the team from simultaneously exploring leading edge materials for both the center span and the other segments of the bridge. The Federal Highway Administration's Innovative Bridge Research and Construction Program encourages innovative materials; for the Church Street South Extension, ConnDOT applied for and received a funding commitment for High Performance Concrete (HPC) and High Performance Steel (HPS).

HPC was used on the bridge deck surfaces and approaches. It blends micro silica fume and fly ash for a less permeable finished concrete and to retard the intrusion of moisture. The goal: to curb concrete deterioration and corrosion of the reinforcing steel. Although stainless steel clad reinforcing bars were originally specified, in the end bars of that composition were unavailable. The truss itself was galvanized steel.

Pushing the frontiers of bridge technology as far as possible and using innovative practices on multiple fronts – notably in preparations for the Big Pick – contributed to the overarching press for accelerated construction.

### **Accelerated Construction**

“The Pick was the primary element in accelerating construction for the project as a whole; it was the opportunity to save a lot of time in one shot and get the work done in a limited window of opportunity,” said Brian Natwick, P.E., Connecticut Department of Transportation Project Manager for the Church Street South Extension Project.

The sequence of events during the hours allotted for the Big Pick left nothing to chance while preserving the fast-track environment. Advance preparations for the night of the actual lift included rigorous tests for the crane pad, rigging, and lift sequence.

Well in advance, the practitioners ensured their taskings would perform like clockwork: secure the work areas for the lift; illuminate the site; check the truss rigging; clear all trains from the area; de-energize the electrified catenary system and power feeder wires; get the “all-clear” for wires and trains; check weather and wind speed to determine if the lift was a “go.”

With the power to electric lines shut off, the preassembled truss line was ready for placement. The crane lifted the span into the air and toward the tracks, where it settled into final position. ConnDOT estimates that the benefits of the “Big Pick,” as compared to conventional erection methods, saved months of contract time.

Several defining elements of progressive accelerated construction techniques merged in the project. Prefabrication and preassembly, state of the art equipment, alternatives for safety, efficiency, and sensitivity to the environment, a tight focus on limiting disruption to customers: all proved, as they have in other States, to be best practices and deadline-beaters.

### **Power of Planning**

Breen singled out planning and constant coordination as the dominant lesson learned from the Big Pick. “The coordination and effort put forth by Metro-North, FHWA, ConnDOT, O&G, the crane people, the city: these caused everything to fall into place.”

“There were constant discussions about what to do, how to do it, giving and taking in a dynamic environment. For instance, the yard itself is a living piece of infrastructure, with many projects going on at once. The contractor’s foresight and continual communication with other stakeholders opened up the possibility of a work area for the truss newly vacated by another project. The site wasn’t available when we initially packaged the project, but nonstop coordination among all interested parties revealed the opportunity to move the site for fabrication, which was vital to success.”

The planning for a project of this magnitude makes the difference, he concluded. “It went off without a hitch. It was flawless,” Breen observed.

### **Team-Driven Performance**

Teamwork backlit and guided the project. Among other accolades for the people behind the project, the National Partnership for Highway Quality awarded the team its 2004 “Making a Difference” Bronze Award for Risk Taking. “This operation was a testament to intelligent, calculated risk taking by a team determined to get the job done while maintaining safe and timely transportation for customers,” said Bob Templeton, Executive Director of the National Partnership for Highway Quality.

Metro-North Railroad’s David Jacobs concluded that “The project took a tremendous amount of coordination, since it affected four different rail lines. Much credit is due to the ConnDOT engineers, the contractor and consultants for the success of the project. The close cooperation between those organizations and the railroad was key.”

The public and private sector partners who delivered the Big Pick and the Church Street South Extension integrated a bridge and roadway with a dynamic community while maintaining safety and performance. They stretched and reshaped ideas about designing and constructing to meet the customer’s expectation – and serve as an outstanding example of the inventive and efficient road and bridge building practices advocated by FHWA’s Highways for LIFE program.



*The Connecticut “Big Pick” project used the largest mobile, land-based and high capacity crane in existence.*